Chemistry of Air Toxics Emitted from In-use Heavy Duty Vehicles Equipped with SCR Retrofits

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INTRODUCTION

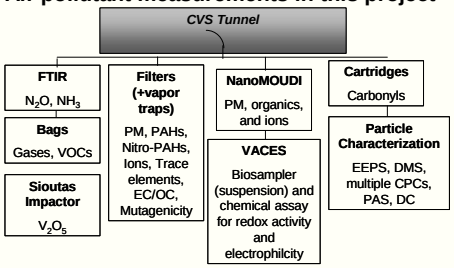
The 2007 California low PM emission standard for new heavy-duty diesel engines results in nearly universal use of aftertreatment devices for these vehicles. This poster presents some preliminary chemical speciation results of an umbrella project investigating the physicochemical and toxicological characteristics of exhaust emissions of in-use heavy- and light- duty motor vehicles in California.

(detailed in Poster 2F.2 Tuesday 9:15AM)

EXPERIMENTAL METHOD

- **Configuration:** four heavy duty diesel vehicles in seven configurations
- **Test cycle:** 50mph Cruise, UDDS, and Idle.
- **Fuel type:** CARB diesel
- **Protocol:** the heavy duty chassis-dynamometer, 40CFR Part 86, Part 89 compliance
- **Sample Collection:** Samples taken from CVS tunnel

Air pollutant measurements in this project



Summary:

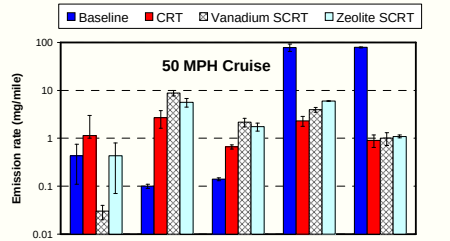
Preliminary results show that a great reduction of PM mass and BTEX emitted from heavy-duty diesel vehicles can be achieved with aftertreatment control technologies. However, emissions of some chemical species, such as sulfate, nitrate, and ammonium (secondary PM), increased. The results presented in this poster are only a small part of this study. Additional chemical speciation results, PAH and carbonyl, as well as from other technologies will be available later. We will carefully assess how these aftertreatment technologies affect the chemical properties of air pollutants, paying special attention to the effect of catalytic surfaces.

Analytical SOP:

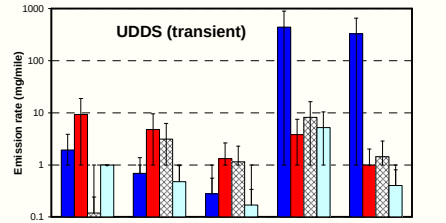
1. http://www.arb.ca.gov/testmeth/slb/sop102-103_version_2.1_final.pdf
2. **Carbonyls:** http://www.arb.ca.gov/testmeth/slb/sop104v3.pdf
3. **Alcohols:** http://www.arb.ca.gov/testmeth/slb/sop101_rev_2.pdf
4. **PDFID:** http://www.arb.ca.gov/testmeth/slb/sop119.pdf
5. **GC/MS:** http://www.arb.ca.gov/testmeth/slb/slb120a.pdf
6. **Nitrous Oxide:** http://www.arb.ca.gov/testmeth/slb/slb136_rev_2.pdf
7. **SOPs for PM analysis available upon request**
   - **Total Carbon Analysis: SOP MLD 139**
   - **Cations and Anions Analysis: SOP MLD 142**
   - **PAH Analysis: SOP MLD 144**

PRELIMINARY RESULTS

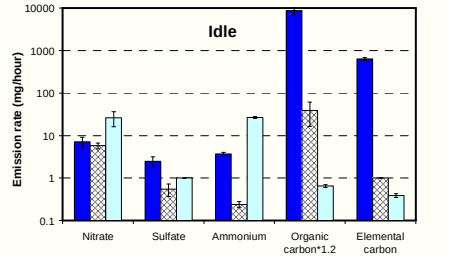
- The single heavy duty vehicle, tested with three different control technologies: CRT, Vanadium SCRT, and Zeolite SCRT
- PM speciation of total carbon (OC and EC), ionic species, and BTEX



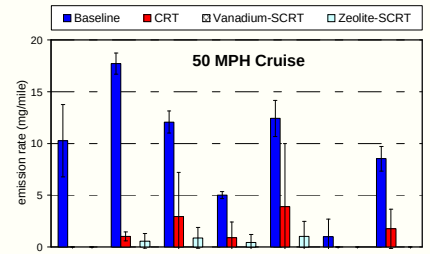
Reporting Limit: 0.045mg/mile for anions, and 1.47mg/mile for total carbon

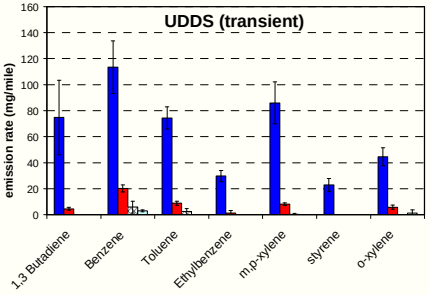


Reporting Limit: 0.12mg/mile for anions, and 3.88 mg/mile for total carbon



Reporting Limit: 1.38mg/hour for anions, and 45.2mg/hour for total carbon





- Urea injection malfunctioned for tests with vanadium SCRT in cruising cycle, N=2

- Tests were not conducted for idle cycle with CRT.

Impact of aftertreatment technology on estimated emission

- More than 95% of PM mass = nitrate + sulfate + ammonium + 1.2*OC + EC
- Significant reduction, as high as 99%, of carbonaceous compounds and BTEX at UDDS and Cruising cycles
- BTEX reduction SCRT (>90%) > CRT (>70%)
- Elevated sulfate, nitrate, and ammonium were observed for samples collected with control technologies, were in agreement with those in literature. Concentrations of these ionic species are in the order of a few ppb.

EC/OC ratios with different after-treatment technologies tested on three different cycles:

	Cruise	UDDS	Idle
Baseline	1.03 ? 0.2	0.76 ? 0.16	0.07 ? 0.01
CRT	0.41 ? 0.17	0.27 ? 0.04	na
Va SCRT	0.25 ? 0.05	0.17 ? 0.04	0 ? 0
Zeolite SCRT	0.18 ? 0.01	0.07 ? 0.02	0.6 ? 0.06

na: no test conducted

The advanced aftertreatment technologies may preclude the use of EC/OC ratios as an indicator of diesel exhaust contribution to ambient air.

See also at AAAR

2F.2 Tuesday 9:15 am: Towards *2010 NOx and PM emission Levels: Overview of CARB's Investigation of Advanced Heavy–duty On-road Vehicle Retrofits and Other Technologies*

4D.2 Tuesday 2:15 pm: *Nucleation Mode Particle Emissions from In-use Heavy Duty Vehicles Equipped with DPF and SCR Retrofits.*

5D.4 Tuesday 4:35 pm: *Physical Properties of Particulate Matter (PM) from Newer Heavy Duty Diesel Vehicles Operating with Advanced Emission Control Technologies.*

Acknowledgement

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